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THE LATE WILLIAM DENNY.

The Life of William Denny, Shipbuilder, Dumbarton. By Alexander Balmain Bruce. With Portrait. (London: Hodder and Stoughton, 1888.)

THE late William Denny was in many ways a remarkable man. He was a prominent member of the modern school of naval architects; an ardent advocate of scientific progress in the design and construction of ships; a strong supporter of scientific education in naval architecture; a contributor of many papers and technical data to the various professional institutions of which he was a member; and an eloquent, indefatigable, and effective exponent of his views upon all subjects. He was also the managing partner of one of the largest shipbuilding firms in the world, and was distinguished for his intimate knowledge of the many and intricate details of the business; for his clear insight into, and close grip of, the questions with which he had to deal; for his eager desire to promote good relations among the members of the firm and the various grades of workpeople in their employ; and for what he did all round towards making the business with which he was connected—as he frequently said it was his ambition to do—“a model of efficiency on all sides.” Both by practice and by precept, William Denny laboured strenuously and effectively, at all times and seasons, for the advancement of his profession, and for the good of those who wished to qualify themselves for the practice of that profession.

The description of Mr. Denny's work as a naval architect occupies only a comparatively small portion of the present book—108 pages out of 478. The remainder consists of general biographical details, and accounts of Mr. Denny's views upon the many local, and the various political, social, moral, and religious questions in which he had a strong—we may say a burning—and ever-increasing interest. This general record of his acts and words will be valued by those who knew the man, and who admired and loved him—as none who really knew him could help doing—and will give to others who may read it a good idea of a life which was full of activity, interest, and promise.

It is, however, the professional work of the subject of this memoir, and not his vigorous, cultured, many-sided, full, and keenly sympathetic mind and life, that we have to do with here. Prof. Bruce, the author, says that the five chapters (VI.–X.) which deal with this branch of his subject “present a popular account of Mr. Denny's technical work, written by one who possesses no knowledge of the technic of shipbuilding.” But they do much more than that, as will be inferred from the fact that Prof. Bruce availed himself of assistance by such competent authorities as Mr. Robert Duncan, the well-known Port Glasgow shipbuilder; Mr. Martell, the Chief Surveyor of Lloyd's Register Society; and Mr. F. P. Purvis, the Chief of the Scientific Department in Messrs. Denny's shipyard.

The name of Mr. Denny is inseparably associated with

modern progress in scientific naval architecture. Prof. Bruce says truly that “in naval architecture he was sometimes in fact, and always in spirit, a pioneer, . . . sagacious to discern quickly the value of a new suggestion or invention, prompt to give it generous recognition, energetic and enthusiastic in taking it up and developing it until it had gained a secure place in general thought and practice;” and he “was of that earnest temper that must and will improve where improvement is possible.”

Mr. William Denny belonged to a family of shipbuilders. “He was the third in succession of three Williams, of whom the two first, his grandfather and his uncle, had been men of genius in the art of shipbuilding.” His grandfather started shipbuilding on his own account in Dumbarton, in 1817, when there was no shipbuilding yard on the Clyde above Dumbarton. He gained renown, during the infancy of steam navigation, as the builder of the Thames passenger-steamer *Marjory*, and of the mail-steamer *Rob Roy*, the first sea-going steamer built, which was employed at first in the Glasgow and Belfast trade, and afterwards as a passenger-vessel between Dover and Calais. He also built the *Trinidad*, the first steamer sent to the West Indies. This William Denny had seven sons, all of whom became shipbuilders. The sole survivor of the seven is Mr. Peter Denny, the father of the subject of this memoir, and the head of the shipbuilding firm of Messrs. William Denny and Brothers, and of other important commercial undertakings, whose long and honourable career and high personal qualities have obtained for him, to an unusual degree, the confidence and esteem of all who know him. Mr. Peter Denny's brother William started the present firm of William Denny and Brothers in 1844. He applied himself with great skill and success to the use of iron in shipbuilding, and in ten years he created a prosperous business. His death occurred at the same early age as that of his nephew, viz. not quite forty years.

The late Mr. William Denny's contributions to the science of naval architecture relate mainly, though not entirely, to the resistance, speed, and propulsion of ships, the stability of ships, the use of steel in construction, and to improvements in structural details and arrangements. He was struck by the report of the British Association Committee in 1869—and particularly by the separate report of Mr. Froude—upon the subject of resistance, and the best way of determining by experiment the relation between speed and power in ships. Mr. Froude enunciated in his separate report the law which connects speed with resistance in floating bodies of varying size but similar forms, and enables the resistance of a full-sized ship to be calculated from that of a small model. He also showed graphically, in the shape of curves, the true variation of resistance with speed, as determined by experiment, for ship-shape models of various forms. Both these points were seized hold of and utilized at once by Mr. Denny for practical application. In January 1870, he commenced to test the speeds of steamers progressively on the measured mile, *i.e.* to determine the relation between engine power and speed at several speeds from the lowest to the highest, and to plot curves, similar to those made by Mr. Froude from model experiments, that showed the true variation of power with speed over the whole practicable range of

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speed, in the vessels so tried. Previous to that time it had been generally considered that it was sufficiently accurate for ordinary purposes to ascertain the power necessary to drive a ship at one or two different speeds only, and to assume that the resistance at other speeds would vary as the square of the speed. The errors often involved by this assumption were known to be considerable; but the practice was not improved upon until the introduction of Mr. Froude's curves of resistance for models, and Mr. Denny's corresponding curves for actual ships.

In 1873, Mr. Denny entered into correspondence with Mr. Froude, and communicated to him from that time forward the results of his experiments upon the speed of ships. Those results, when compared with what were given by model experiments, were of great assistance to Mr. Froude in his investigations. Mr. Froude said, at the Institution of Naval Architects, in 1876: "Mr. Denny's horse-power results, when closely scrutinized, were found at once to supply most important information on the subject of engine friction; and they have helped to corroborate and further elucidate certain general conclusions on the subject of the expenditure of power in propulsion, which other less crucial tests had enabled me to arrive at approximately." Mr. Froude read a paper, from which the foregoing is a quotation, in which he used the data referred to for determining the ratio of indicated to effective horse-power in ships. He also read a second paper, at the same meeting, in which he said that "the trial of Mr. Denny's ship *Merkara*, referred to in the paper I have already read, furnished materials for extending and giving practical completeness to a comparison [of the resistances of long ships of several types] which our series of experiments had already led us to institute between several types of form." This furnishes an excellent illustration of how progress may be facilitated by the close co-operation of the scientific investigator and experimentalist with the practical worker who requires to understand and apply the teachings of science; and it is one proof out of many of the scientific value of Mr. Denny's early speed trials, and of his readiness to communicate freely the results to others interested in the subject. Mr. Denny laboured with great enthusiasm to perfect the data obtained on measured mile trials of ships, and to collect and record it systematically; and he was always ready to place such information at the disposal of other workers in the same field.

Mr. Denny read a paper, in 1875, before the Institution of Engineers and Shipbuilders of Scotland, on "The Difficulties of Speed Calculations," in which he strongly insisted upon the uselessness of the ordinary speed formulas, and urged the desirability of having all steamers, if possible, tried progressively. He gave conclusive force to his arguments by exhibiting curves of power and speed for several ships, which showed large departures of the curves given by the standard formulas from the curves which had been deduced from actual trials of the ships. He never afterwards ceased to call attention to the great advantage of the improved system of speed trials; and he soon had the satisfaction of seeing it brought into general use. Mr. Froude said, in 1876, in one of the papers above referred to: "It is to Mr. Denny's honour that, finding the so-called constants [in the speed formulas

then in use] were invariably variable and inconstant, he determined of himself to strike out a new line, and find out by trial what is fact, instead of contenting himself with assuming what ought to be the relation between indicated horse-power and speed."

In 1881, Mr. Denny, with the consent of his partners, took the important step of erecting an experimental tank in the shipyard at Dumbarton for the purpose of carrying out independent trials of the resistance of models such as Mr. Froude had long been doing at Torquay. So long before as 1877 he said at a meeting of the Institution of Naval Architects: "The attention of all mercantile naval architects should be called to the fact that all Mr. Froude's experiments bear strongly and directly on our work; and unless we follow them thoroughly and follow them accurately, and with an anxious spirit, we shall not succeed as we ought in taking the lead of those countries interested in shipbuilding." His biographer says that in 1881, when a large extension of the Dumbarton shipyard was commenced, "the erection of an experimental tank became a subject of serious consideration with Mr. William Denny. He had become convinced that the expenditure involved in the construction and maintenance of such a tank would be justified by its utility. The result was that the present Dumbarton tank, the only one either in existence or in contemplation under private control, was devised, constructed, and equipped." The magnitude and difficulty of the work will be understood when it is remembered that the water-space contained in the so-called tank is 300 feet long and 22 feet broad, and the depth of water 9 feet; that the models experimented upon are fashioned out of solid paraffin by mechanism originally devised by Mr. Froude for the purpose; and that the models are towed from end to end of the tank by means of an overhead carriage fitted with delicate apparatus for accurately measuring the speed of the model and the force applied to maintain it at that speed, and for automatically producing a graphic record, in a form suitable for subsequent measurement and calculation, of the results of each experiment. The outlay and thought demanded by such an extensive, complicated, and novel undertaking was very great; but the greatest difficulty of all would be the formation of a staff competent to make it fruitful and successful in results. Mr. Froude was a man of genius, and everyone could not work with his tools. However, Mr. Denny soon organized a staff of skilled assistants who have proved their fitness for the task to which they were put. Prof. Bruce says that "since the tank was opened some twenty thousand experiments have been made on models of ships previously built and tried on the measured mile, or of ships in process of design, or of ideal ships conceived for the purposes of experiment."

Mr. Denny did much to simplify and improve the methods of calculation for determining a ship's stability, and to apply the known science of the subject to the practical work of the designing office. In 1880 he commenced the practice of ascertaining by experiment the position of the centre of gravity of every ship built by his firm; and the data thus obtained for numerous ships were perfected and carefully systematized for guidance in the preparation of new designs. Amsler's mechanical

integrator, and other mechanical devices for reducing the labour of calculations made in a naval architect's office, were extensively used; and the time required for such work was reduced to a small fraction of that formerly expended. The integrator was modified by its inventor at Mr. Denny's suggestion, so as to be better fitted for the special work of stability, and other, calculations; while, on the other hand, the integrator was used so as to enable large simplifications to be effected in the systems of calculation. The manner in which the mechanical integrator was used in Mr. Denny's office to reduce the time and labour involved by laborious calculations, and to effect improvements in the methods of calculation themselves, is well illustrated by one of Mr. Denny's most valuable contributions to the science of naval architecture, which is contained in a paper on "Cross Curves of Stability, their Uses, and a Method of constructing them obviating the Necessity for the Usual Correction for the Differences of the Wedges of Immersion and Emersion."

Mr. Denny, as was his custom throughout, gave a practical direction to his work in connection with the subject of stability, by preparing for each steamer built by his firm general particulars of her technical qualities, "such as dead-weight capability, speed and power, stability," and other matters of importance, for the guidance of her owner and captain.

Mr. Denny was one of the most prominent advocates and pioneers of the recent change from iron to mild steel as the material of a ship's construction. He was the builder of the *Rotomahana*, the first mercantile ocean-going steamer constructed of the new material—a vessel which soon answered objections made to the use of steel by grounding on a rocky bottom and proving its superiority over iron when subjected to the roughest of treatment. Mr. Denny showed, in a paper read before the Iron and Steel Institute in 1881, that the extra cost of steel per ton would be more than counterbalanced by savings effected in the weight of structure, and by the additional weight of cargo that could thus be carried. The truth of this view was soon proved by the commercial results of the use of steel ships. He was always a consistent advocate of the use of steel, and a stout upholder of its merits against all attacks; and he often pointed out with great force and truth that defects arising from faulty design or bad work had been attributed to the material itself. Hence he strongly urged the necessity for more careful study of structural defects, and of what he called the "morbid anatomy of ships."

It is impossible, within the space at our disposal, to deal thoroughly with, or even to notice all of, the many subjects associated with Mr. Denny's name. He did much to improve the structural details of design, and to bring about the introduction of double bottoms into mercantile steamers. He was always an able and close critic of the rules by which Lloyd's surveyors are guided in the survey of ships for classification, and of the manner in which those rules are carried out. He proposed, in 1877, to frame new rules, by which the displacement of a vessel would be the standard for regulating the thickness of the plating and the sizes of the frames and other parts. Mr. Denny's arguments were met with what, at the time, may have been a sufficient answer, viz. that there were

no fixed load-lines for ships, and therefore there was no definite amount of displacement. This answer does not now hold good, however, seeing that since the report of the Load-line Committee, in 1885, full means have been in operation for fixing the load-lines, and therefore the displacements, of ships. But there still remains much to be said, on both sides, about Mr. Denny's proposals.

Mr. Denny did some very valuable work as a member of the Load-line Committee, a description of which will be found in Chapter IX. In that Committee; at an interview with the President of the Board of Trade in 1883; in giving evidence before the Royal Commission on Loss of Life at Sea in 1885; and on all other suitable occasions, Mr. Denny advocated a reform of the Marine Department of the Board of Trade, in the direction of forming a Board whose members would have personal knowledge of the subjects dealt with and the interests affected by them, and of strengthening the executive staff of that Department by furnishing it with the best scientific assistance that could be procured.

The cause of technical education never had a stronger supporter than Mr. Denny. He advocated it, and worked in it, at all times and seasons. Everyone engaged in the scientific teaching of naval architecture had his eager encouragement and generous help. The writer owes much to him for practical assistance of every kind in connection with the commencement and carrying on of the work of the Chair of Naval Architecture in Glasgow University. Mr. Denny was always ready to apply the resources of his establishment to the benefit of others who were working in the cause he had at heart. He was an ardent advocate of technical education for all who were entering the shipbuilding profession. His own early training was very thorough, and he qualified himself, as the record of his work proves, to occupy the first rank among naval architects. Yet we find him dissatisfied, and saying in 1883 to one who consulted him as to sending a son to the Royal Naval College, "None of the rest of us [the exception referred to is his brother Mr. Archibald Denny, who now ably fills his place at the works] were at the College, and it will be a lifelong regret to me that I missed its advantages. . . . The work of these schools [of naval architecture] is the heaven which is slowly but profoundly inspiring and changing the character of our profession." The practical efforts made by Mr. Denny himself among his own people to improve their technical training are best described in his own words. In 1883, he said:—

"Our attempts at technical education in our shipyard and engine-works consist of the following:—

"(a) Rules as to the admission, by examination, of apprentices and others into the shipyard offices.

"(b) The same for our engine-works.

"(c) Rules to the Awards Committee to guide them in rewarding the workmen for inventions or improvements.

"A similar scheme of awards has been begun in our engine-works.

"From these papers and the private information given to you as to the awards made, you will observe that our attempts to stimulate the intelligence of our *employés* have developed in two forms, corresponding to the main divisions of these *employés*. First, by examination we have tried to secure a supply of apprentices and others for our offices elected by ability and steadiness, and with some knowledge suitable for the careers before them.

Second, we attempt by rewards to stimulate the minds of our workmen directly to invention and to a continual criticism of the methods of work, tools, and machines employed by them. We have not tried yet to induce them to attend technical classes, but a few of them do attend such classes in the town, conducted under the control of the Science and Art Department.

"All our draughtsmen attend such classes, and in addition have from us the use of our offices, with paper, &c., free, also of a very complete library of works on naval architecture and cognate subjects, every evening excepting Saturday and Sunday."

Mr. Ward, the managing partner of the firm, reported, in 1887, that, since the introduction, seven years before, of the system of awards to workmen for inventions and improvements, "claims have been considered valuable and worthy of award to the number of 196, while rather more than three times that number have been considered altogether."

Want of space prevents our saying more respecting the subject of this memoir, though much more might be said with advantage. The early termination of Mr. Denny's career is an irreparable loss to his profession and to the cause of scientific progress in ship construction. The last professional distinction conferred upon him was that of being elected President of the Institution of Engineers and Shipbuilders in Scotland; but he did not live to deliver his Presidential address. This circumstance in connection with his death is similar to what happened in the case of a celebrated predecessor in that office, also a Clyde shipbuilder. We refer to Mr. John Elder, who died in the prime of life almost immediately after the members of the Institution elected him as their President in 1869.

FRANCIS ELGAR.

MEMORY.

Memory: its Logical Relations and Cultivation. By F. W. Edridge-Green, M.B., B.S. Durham. (London: Baillière, Tindall, and Cox, 1888.)

THE title of this book is somewhat misleading. "Memory: its physiological" or "organic conditions," would be more pertinent, for "logical relations" suggest a treatment of mental association more allied to that offered, for instance, by Dr. Bradley in his "Principles of Logic." This will probably appear a trifling remark to the author, niceties of terminology seemingly being of small importance in his eyes. Throughout his work the writer lightly passes from the corporeal to the mental sphere with a serene indifference to the needs of clear conception.

The author's stand-point may be understood from the following paragraphs of the introduction:—

"What is memory? It is the process by means of which impressions of the external world and ideas are retained for use on future occasions. . . .

"Memory must be clearly distinguished from remembrance and recollection. Recollection is the power of voluntarily recalling impressions. Remembrance is the term applied when the process is involuntary. Memory is the innate power to have an impression recalled if a proper stimulus be applied. . . .

"All the above appears at first sight to be strongly against the view that memory is a definite faculty occupying a limited portion of the brain. But in the follow-

ing pages I shall endeavour to prove that memory *is* a definite faculty, and has its seat in the basal ganglion of the brain, separate from, but associated with, all the other faculties of the mind."

Mr. Edridge-Green evidently does not fear the reproach of heresy, for there is hardly a sentence of the foregoing that would not be condemned by the authorities of the day. Whether memory be defined as "the process by means of which impressions and ideas are retained," or "the innate power to have an impression recalled" (we leave it to the author to reconcile his own language),—to mark it off from "remembrance and recollection" would, by most psychologists, be regarded as making a distinction without a difference. And, further, to maintain that "memory is a definite faculty occupying a limited portion of the brain," with "its seat in the basal ganglion," undoubtedly is a proof of independent opinion, if not of scientific discretion.

We are treated in chapters v. and vi. to an account, at some length, of "the faculties of the mind," as well as—although we had been told that memory is a definite faculty occupying a limited portion of the brain—of "the special memories" appertaining to the same. The faculties turn out to be thirty-seven, the number being five short of those alleged in "the phrenological system," the items of which are in part rechristened, and also rearranged. Regarded as conformity to popular description, there may be no great harm in all this; but something more than language is at fault in the statement that "the mind is made up of a number of faculties, each of which responds to certain impressions, and influences the mind as a whole to seek after these impressions, and to avoid their negatives." Indeed, many of the author's perplexities, and much of the reader's difficulty in comprehending him, are clearly traceable to the adoption of this somewhat antiquated and crude way of regarding the mental constitution. The topic, however, must not detain us, and we proceed to consider the author's refutation of "the hypothesis that the perception and memory of any impression occupy the same portion of the brain."

Eight reasons are apparently offered. No. 1 had perhaps best be given in the author's own words:—

"They [*i.e.* perception and memory] are totally distinct functions; thus, the eye receives the impression in the first place, but no one supposes for an instant that the eye is the seat of the memory of impressions of sight. . . . Why should the brain, having manufactured ideas, &c., remember them? The cerebral hemispheres bear exactly the same relation to the basal ganglia as the external senses do, and there is no evidence to support the theory that the cerebral hemispheres are the seat of memory."

The reasoning apparently is: the cerebral hemispheres (which possess the property of *manufacturing ideas*) stand "exactly in the same relation to the basal ganglia as the external senses." Now it is admitted that the eye, or external sense, remembers nothing, therefore neither can the cerebral hemispheres. Is this meant for reasoning, or mere dogmatism? No one who has not a theory to support would press the analogy of the eye and the cerebral hemispheres; resting as it does on nothing better than a vague resemblance of the minute structure of retina and cortex; rather, if analogy is to count for anything, it is the "basal ganglia" that should be likened to